REMARKS

The present application includes claims 1-23, which currently stand rejected. Claim 1 has hereby been amended.

35 U.S.C 102(b) Rejection

Claims 1, 2 and 17 stand rejected under 35 U.S.C. 102(b) as being anticipated by Sasaki et al. (U.S. 5, 986,788). The Examiner states that, in regards to claims 1 and 2, Sasaki et al, disclose an optical coupling system comprising: a first lens with an incident surface disposed in a certain direction and having a positive refractive power, whereby a Gaussian beam-like luminous flux incident on the incident surface from a light source is converted into an approximately parallel luminous flux; and a second lens having the same refractive power (as the first lens) inherently having an incident surface and exit surface disposed in a reverse direction. In the second lens, the approximately parallel luminous flux is incident on the incident surface and is converted into a converged luminous flux, the converged luminous flux being incident on a light-receiving unit. Examiner further states that a distance 2L between the two lenses is selected to be in a range given by an expression $1.8Lmax \leq 2L \leq 2Lmax$, in which 2Lmax is a maximum distance that would inherently allow beam waists to be formed at equal distances from the two lenses. Examiner states that this is reasonably assumed because Sasaki et al. disclose Lmax ($L_2 + L_3$) is determined by ω_2 and ω_4 utilizing equation 3 in the reference, where variables ω_2 and ω_4 can be chosen from an infinite number of sets satisfying Lmax, which would inherently include ω_2 and ω_4 being equal. Regarding claim 17, Examiner states that Sasaki et al. discloses the case in which the first and second lenses are the same.

Applicant respectfully disagrees.

Sasaki et al. addresses the problem of the need to have extremely high positioning accuracy with respect to the arrangement of the elements of a traditional microoptical system in the case where several optical systems are successively arranged, such as between successively arranged electronic chips. Since positioning errors are cumulative, the already small margin (1-2 μm for a single optical system) is not sufficient for several optical systems in a row. The invention provides a way of lowering the required positioning accuracy level without

compromising signal accuracy. The proposed solution is to configure the light source, the photodetector, and the two groups of lenses so that ω_2 (the effective Gaussian-beam radius of the first lens) is greater than ω_4 (the effective Gaussian-beam radius of the second lens) (column 8, lines 14-21). Maintaining this relationship between ω_2 and ω_4 allows a minimal distortion of the signal while achieving a desired value of L_{max} ($L_{max} = L_2 + L_3$, where L_2 is the distance from the first lens to the beam waist intermediate between the two lenses, and L_3 is the distance from the intermediate beam waist to the second lens).

Thus, the method employed in the invention of Sasaki et al. is to adjust the effective Gaussian-beam radius ω_2 of the first lens to be greater than the effective Gaussian-beam radius of the second lens, ω_4. This arrangement allows combining successive electronic chips without accumulating optical errors by "absorbing" point-light-source positional -deviation errors caused by flip chip bonding (column 2, lines 17-21).

In order to practice the method of Sasaki et al. , one calculates distances L1, L2, L3 and L4 according to equation (1) (column 6, lines 16-30). The distances may be obtained "by using the effective beam radiuses ω_2 and ω_4 and a light-source wavelength...λ". As stated elsewhere, λ, ω_1 and ω_5 are given (column 3, lines 16-17) and depend on the semiconductor device to be used (column 6,m lines 39-41). ω_2 and ω_4 for use in the calculation are also previously given (column 6, lines 44-45), leaving ω_3 as the "free parameter". By utilizing equations (2), (3) and (4), (columns 6 and 7) one can set the components L1 to L4 and the focal lengths f1 and f2 (column 7, lines 54-61). According to the invention of Sasaki et al., ω_2 and ω_4 are selected so that ω_4 is smaller than ω_2, i.e. the ratio of the two parameters is varied. Because it is the ratio of the two that is varied, however, the target L_{max} remains fixed as calculated.

In contrast, the inventors of the subject matter of the present application have discovered that, in an optical configuration system, maintaining an L_{max} so that $1.8L_{max} \leq 2L \leq 2L_{max}$ very effectively minimizes coupling loss in an optical system. For example, if it is known that due to humidity or temperature changes, L will from time to time increase in an optical system, using the method of the present invention, one could design the optical system so that L was less than L_{max} (but not less than $1.8L_{max}$) in order to build in leeway for the expansion to occur without

seriously compromising optical transmission. L_{max} can be calculated as described by Sasaki et al. (ABCD matrices for this purpose are well known) but can then be varied (for any reason) within the range without seriously compromising signal coupling. Applicant notes that if the simple method of the present invention were employed in an optical system, this could obviate the need for a method such as that of Sasaki et al.

Applicant is puzzled by Examiner's comment that "variables ω_2 and ω_4 can be chosen from an infinite number of sets satisfying L_{max}, which inherently would include ω_2 and ω_4 being equal (column 7, lines 62-67)". Examiner is apparently equating this statement with the feature of claim 1 which states that, by selecting the distance 2L to be given by $1.8L_{max} \leq 2L \leq 2L_{max}$, 2Lmax is a maximum distance allowing beams waists to be formed at equal distances from the two lenses. However, Sasaki et al. in the passage cited by the Examiner, refer to an "infinite number of sets of values of the two effective beam radiuses ω_2 and ω_4. Thus, Applicant submits that Examiner's equating of this portion of the disclosure of Sasaki et al., to the subject matter of claim 1 is misapplied.

Applicant further submits that there is no teaching or suggestion in Sasaki et al. regarding maintaining L of an optical system so that $1.8L_{max} \leq 2L \leq 2L_{max}$ in order to minimize coupling loss due to lens aberrations, changes of temperature and humidity, and the like. Thus, Sasaki et al. do not anticipate the subject matter of the claims of the present application.

Further, claim 1 has hereby been amended to recite that the "light receiving source" is an optical fiber. Support for this amendment is found in the specification, for example, in the paragraph beginning on page 7, at line 24 and continuing through page 8, line 4, where the light receiving unit is described as constituted by an optical fiber. Applicant submits that this amendment thus does not constitute the addition of new matter. Sasaki et al. does not disclose receiving the Gaussian beam by an optical fiber. applicant submits that this 35 U.S.C 102(b) rejection is thus overcome.

In view of the foregoing, reconsideration and withdrawal of this rejection are respectfully requested.

35 U.S.C 103(a) Rejections

Sasaki et al., in view of Dempewolf et al. (US 5,815,318)

Claims 8-11 stand rejected under **35 U.S.C 103(a)** as unpatentable over Sasaki et al., in view of Dempewolf et al., (US 5,815,318). Examiner states that Sasaki et al. provides disclosure as above, but does not specifically disclose that the lens having a positive refractive power is a rod lens, a plano-convex lens, or a sphere lens, and that the teaching of Dempewolf et al. supply this deficiency. Applicant respectfully disagrees.

Sasaki et al.'s invention is basically related to optical coupling systems where the lenses are asymmetric, although a comparative example shows a symmetric system. That is, while Sasaki et al.'s invention is directed to provide two lenses having mutually different properties, claim 1 of the present application limits the first and second lenses to having the same refractive power, and claim 3 claims a single lens and a reflection surface. In Sasaki et al.'s system, a Gaussian beam from the light source is received by a photodetector. In the presently claimed invention, the Gaussian beam is provided and received by an optical fiber.

The applicant claims preferred conditions in a specific optical system (namely a light source to optical fiber through a symmetric lens pair) so as to obtain the preferred optical properties of the system. Such preferred conditions are obtained from a multiplicity of combinations of optical elements for each optical system, and they are dependent on the basic structure and required characteristics of the system. Sasaki et al.'s basic structure is different from that of the presently claimed invention. Therefore, there is no reason to selectively apply one of the conditions presented in the Sasaki et al. invention to the basic structures as claimed in the present case, in order to obtain the results required in the present application.

Specifically, tolerances in producing and assembling optical parts are very important factors in optical systems. However, it is impossible to attain a lens arrangement in which tolerance in every respect is ideal. Rather, lens systems are designed as optimized lens arrangements in which some tolerances are not ideal due to constraints, practical limitations, and requirements of the system.

In Sasaki et al. , the optical system is constituted by a light source, a pair of convex

lenses and a photodetector. In order to avoid the spreading of the spot of the Gaussian beam over the reception surface of the photodetector, Sasaki et al. propose lens arrangements by which the position of the spot is hardly moved at all on the reception surface of the photodetector. On the other hand, Sasaki et al.'s arrangement tolerates a relatively large defocusing (spot shift in a direction of the optical axis) and change in spot diameter due to a change in magnification. To satisfy the specific requirements, Sasaki et al. reached the asymmetrical arrangement where the beam waists ω_2 and ω_4 are different from the numerous combination of lenses. Although Sasaki et al. show the symmetrical arrangement where the beam waists ω_2 and ω_4 are identical to Figs. 2 through 10, <u>Sasaki et al. merely show this arrangement as a comparative example that shows undesired results to the photodetector</u>. There is no motivation to apply this lens arrangement to an optical system where the beam is received on an optical fiber since no specific advantage would be expected based on Sasaki et al.'s disclosure, which is silent about the reception of the beam at an optical fiber, i.e. Sasaki et al. neither show nor suggest reception of the beam at an optical fiber.

On the contrary, to reduce coupling loss as discussed in the present application, it is important to lower defocusing of the spot and to prevent change in the spot diameter due to magnification changes as much as possible. To satisfy such requirements, the inventors of the present application have devised a symmetric lens arrangement requiring a particular range of distances.

As discussed above, the difference in the light receiver causes the difference in technical issues. Thus, the present invention is not obvious in view of Sasaki et al. alone. Moreover, there would have been no motivation to combine Sasaki et al. with any other reference.

In addition, claim 3 recites the reflection of the beam by a reflection surface. This basic structure is neither shown nor suggested by Sasaki et al., and motivation is given to combine Sasaki and any other reference to obtain the subject matter of claim 3, or its dependent claims.

Further, Applicant has shown above that Sasaki et al. neither show nor suggest maintaining L within a range such that $1.8L_{max} \leq L_{max} \leq 2L_{max}$ in order to minimize coupling loss in an optical coupling system. Dempewolf et al. also neither shows nor suggests maintaining L

within a range such that $1.8L_{max} \leq L_{max} \leq 2L_{max}$ in order to minimize coupling loss in an optical coupling system. Therefore, no combination of Sasaki et al. and Dempewolf et al. can render the subject matter of claims 8-11 obvious.

Sasaki et al. in view of Hamanaka et al (U.S. 2001/0024548 A1)

Claim 12 stands rejected under 35 U.S.C. 103(a) as unpatentable over Sasaki et al. and further in view of Hamanaka et al (U.S. 2001/0024548 A1). The Examiner states that Sasaki et al. disclose as previously discussed, but do not teach that the lens has a grating lens surface. Examiner states that Hamanaka et al. teach that it is well known in the art to have optical fibers coupled by lenses having a grating lens surface (i.e. Fresnel lens).

As discussed above, Sasaki et al. does not teach the present invention. Thus, a combination of Hamanaka et al. with Sasaki et al. cannot render the subject matter of claim 12 obvious, for Hamanaka et al. supplies only the teaching of optical fibers coupled by lenses having a grating lens surface.

Sasaki et al. in view of Huang et al. (U.S. 2003/0108312 A1)

Claims 6, 13 and 14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Sasaki et al. in view of Huang et al. (U.S. 2003/0108312 A1). The Examiner states that Sasaki et al. disclose as previously discussed, but do not disclose the case in which the light source and the light-receiving unit are constituted by end surfaces of optical fibers which are equal in mode field diameter. Examiner states that Huang et al. supply this teaching in that they teach that it is well known in the art of optical fiber coupling for optical output components to include lasers or fibers, particularly wherein the optical fibers are equal in mode field diameter.

As discussed above, Sasaki et al. do not teach the present invention. Thus, the combination of Sasaki et al. with another reference such as Huang et al., wherein what is taught is only that output components may include lasers or fibers (particularly fibers equal in mode field diameter) cannot render the subject matter of claims 6, 13 and 14 of the present invention obvious.

Mooradian (U.S. 5,327,447)

Claims 3, 4, 7, 15, 16 and 18 stand rejected under 35 U.S.C. 103(a) as being

unpatentable over Mooradian (U.S. 5,327,447). The Examiner states that with regard to claims 3 and 4, Mooradian discloses an optical coupling system comprising: a lens having a positive refractive power, by said lens Gaussian beam-like luminous flux incident on the incident surface from a light source being converted into approximately parallel luminous flux, and a reflection surface dispose at the rear of the lens so that the approximately parallel luminous flux is reflected by the reflection surface to return to the lens. According to Examiner, the returning luminous flux is converted by the lens into converged luminous flux which is incident on a light receiving unit disposed in the light source, in which a distance L between the lens and the reflection surface is selected to be in a range given by the expressions of claims 3, 4, 7, 15, 16 and 18. Examiner further states that it is not inventive to discover optimum conditions or workable ranges by routine experimentation, and that such experimentation is no more than the application of the expected skill of an engineer.

Applicant disagrees with Examiner's remarks.

Mooradian teaches a waveguide optical resonant external cavity laser. With reference to Figure 1, what is shown is a laser light source, beam shaping optics (i.e. a lens, either spherical [1a-1c] or cylindrical [1d]) and a mirror that is planar if the lens is spherical, or cylindrical if the lens is cylindrical. The beam shaping optics may include a waveguide. The use of such an external cavity on a semiconductor laser overcomes problems such as stimulated and spontaneous emission.

Moordian offers no discussion whatsoever regarding the placement of the lens in respect to the mirror. The sole commentary regarding lens/mirror placement is found in column 4 at lines where the lens assembly is described as fitting into "a positioning barrel bracket **418** which is moveably mounted in a positioning bracket **418**. The barrel **420** is made so as to move along the axis of the cavity and thereby allow the focusing of the light from the laser diode." No indication or suggestion is given for how focusing should be carried out. One practicing the method of Moordian is left to utilize unnamed techniques, or to trial and error?

In contrast, the present invention provides an optical coupling system in which this problem is solved, the inventors having discovered that the distance L between a lens and a

reflection surface should be set in the range of $0.9Lmax \leq L \leq Lmax$.

In summary, Moordian neither shows nor suggests the optical coupling system of claim 3, and thus claim 3 and dependent claims 4, 7, 15, 16 and 18 cannot be deemed obvious in view of Moordian.

In view of the foregoing, reconsideration and withdrawal of this rejection are respectfully requested.

Formal Matters and Conclusion

In view of the foregoing, Applicant submits that all rejections have been successfully traversed and that claims 1-23 should be deemed new and unobvious over the prior art of record. The Examiner is respectfully requested to reconsider and pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

Please charge any underpayment or credit any overpayment of fees to attorney's deposit account #50-2041.

Respectfully submitted,

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